Low Contrast Image Segmentation and Enhancement Using Histogram Equalization Techniques.

Project report submitted in partial fulfillment of the requirement
for the degree of Bachelor of Technology

in

Computer Science and Engineering/Information Technology

By
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Candidate's Declaration

I hereby declare that the work presented in this report entitled **"Low Contrast Image Segmentation and Enhancement Using Histogram Equalization."** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering/Information Technology** submitted in the department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from July 22 to July 23 under the supervision of **Dr. Nafis Uddin Khan** and Co-supervision of **Dr. Himanshu Jindal.**

I also authenticate that I have carried out the above-mentioned project work under the proficiency stream **Data Science**

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

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This is to certify that the above statement made by the candidate is true to the best of my knowledge.

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ABSTRACT

With today's imaging technologies, the human eye may only see very little. They may frequently be brought on by a loss of clarity, like atmospheric influences brought on by haze, fog, and other daytime impacts that affect the visuals. Image enhancement techniques are becoming more and more common and helpful in these situations because it is important to clarify and improve the pertinent information obtained under those circumstances in order to identify the objects as well as other useful information. Image enhancement, which is essential for making an image useful for a variety of purposes, including those related to digital photography, medicine, geographic information systems, industrial inspection, law enforcement, and many other digital image applications, is one of the key components of digital image processing. Image augmentation can assist to improve low-quality images. The major goal of this study is to try to improve the quality of digital images using histogram equalization and histogram specification. In this project, we're using various histogram equalization approaches on various sets of photos to see which one produces the greatest results.

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Chapter 1 Introduction

1.1.1 Introduction

Situations in the actual world typically suffer from poor clarity and lowlight effects. Contextual information can be extracted more successfully from high dynamic range images. Where nighttime photographs were captured, they can contain low brightness and suffer from noise because of the weak signal.

The project's goal is to make important information more visually appealing by increasing contrast and color. These methods can be utilized for pixel segmentation and analysis of detection. Normally, thislow light image augmentation is needed for a variety of applications, such as surveillance, astronomy, and medical imaging.

The introduction of HE (histogram equalization) is a rather straightforward approach and typically results in the introduction of various artifacts and a substantial loss of nuances in the picture. That flips the dark input in order to improve the low-light image De-Haze algorithm is then provided to enhance the illuminant component between frames. Componentss and parameterss issues resulted in the introduction of artifacts during image reconstruction.

Early solutions to the issue included sparse representation technique. Its is a straightforward method that introduces crucical data from the image. Therefore, it is necessary to improve the reconstruction’s quality and provide alternate function operators.

In this project we present different types of Histogram equalization techniques like Adaptve Histogram Equalization (AHE), Contrast Limited Adaptie Equalization (CLAHE) followed by some denoising techniques to enhance the results.

1.1.2 Problem Statement

The primary goal of this project is to explore contrast and different ways that we may use existing techniques like V transformation and histogram equalization to considerably increase it. Several types of histogram techniques are also discussd and well each and every one of them performs on a particular type of image.

1.1.3 Objectives

The comparison of the three alternative picture processing and enhancement approaches is the major goal of this project. Juyter Notebook and Google Colab are employed in the process.

1. Histogram Equalization
2. Adaptive Histogram Equalization
3. Contrast Limited Adaptive Equalization (CLAHE).

1.2 DIGITAL IMAGE PROCESSING

1.2.1 Picture and Image:

Humans are typically visual organisms who primarily rely on their vision to sense their environment, as was previously established. They are able to scan the area and quickly gather the general impression without just visualizing the objects.

Humans can discern faces easily, differentiate between colours, and process a large amount of visual information swiftly. For the sake of this discussion, an image is defined as a single photograph that can show a person, an animal, a landscape, a microphotogrph of an electronic component, or the result of a medical imagiing operation. It will not be a random blur, even if the image is not immediately vissible.

1.2.2 What Is Image Processing?

In order to improve the visual information in a picture for human interpretation and to make it more suitable for autonomous machine perception, the image's attributes must be changed. Digital image procesing entails changing the nature of a picture, which is what it is concerned with. Simple, uncluttered visuals are preferreed by machines over sharp ones, which people like. The edges of a picture are improved to make them look sharper. Figure 1(a) serves as a specimen.

The second image is therefore sharper than the first. Sharpening is chosen sinceit is necessary for printing for the edge to look excellent on the printed page.

(a) The original image (b) Result after "sharperning"

Fig 1 Two distinct images showing the difference after applying the contrast enhancement technique.

1.2.3 Digital Images:

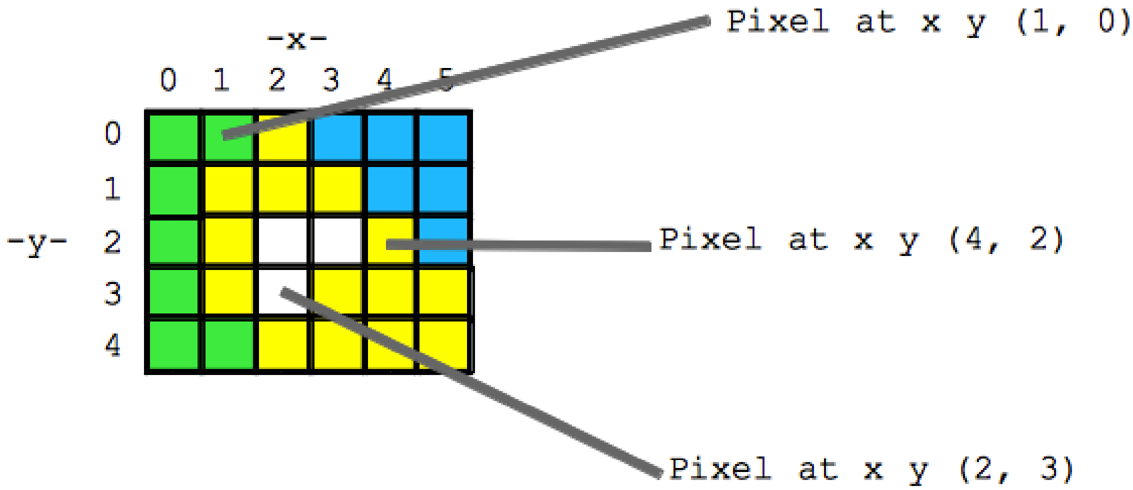
For the time being, think of a black and white or colorles image. The values of the two-dimensional function that these pictures are then assumed to be imply the brightness of the image at any given moment. Assume for the moment that the brightness levels in these images may be described as real integers between0 and 1, with 0 denoting darkness and 1 denoting whiteness.

The scale of x and y will undoubtedly be affected by the image, but they are genuinely scaling from low to high values. A digital picture is essentially a two-dimensional arrayof light intensity levels as opposed to a real-time snapshot, where the sptial coordinates (x, y) define the intensity of image at a certain place and the fuunction as f(x, y) is represented as disjoined. Since these numbers are frequently integers, the brightness level values for the image will range from 0 to 255, or from white to black, and 0 and 1 will each contain values between 1 and 256. Digital images can be visualized as a large group of unique dots, each with a different brightness level.

They are known as pixels or the components of an image.

By varying the three main colors' proportions, or RGB, new colors can be produced (red, green, blue). The three-dimensional matrix NxM 3 is used to depict a color image, with each layer indicating the distribution of the primary color's gray levels. A pixel is the term used to describe each point in the image whose (x, y) coordinates are given. The smallest unit of info. in the image is a pixel.

It includes the figures for the intensity level that corresponds to the irradiance that was detected. The contrast required to distinguish between objects and regions is provided by the difference in the grey levels of two adjacent pixels. To be recognised as a boundary by the human eye, a difference must be of a certain magnitude.



Grid image showing the pixel as co-ordinates.

1.2.4 Application

A wide number of fields, mostly science and technology, can benefit from image processing techniques. An overview of a few applications for image processing will be discussed below.

- Medicine Examining and describing images from various medical applications such as X-rays, MRI scans, and cell analysis such as chromosome karyotypes.
- Aerial and satellite images of the land can be used in agricultureto determine how much land is used for certain activities, whether an area is suitable for growing a particular crop, and whether or not fresh or expired produce is being used.
- Inspection of products on a production line automatically.
- Deblurring or enhancing the speed camera images for face recognition in law enforcement are examples of fingerprint analysis.
- Space images mostly comes out black and noisy and that's why with the help of this technique we will be always to reduce noise and graininess, resulting in a better photograph with much better contrast and details for further details.

1.2.5 Types Of Digital Images

1.2.5.1 Binary Image:

Each pixel requires one bit and can have one of two values. Pixels only comein black or white. As a result, such photographs may be effective in terms of storage. [3] Examples of images that might be represented in binary include text, fingerprints, and others. The figure below has two colors: black for the background and white for the edges.

Plotting a histogram of the intensities of a grey-scale image is the first stage. It chooses a threshold intensitty. Pixels are marked "white" or 1 if they fall below this threshold and "black" or 0 if they rise over it.

In the best situation, locating the local minimum between the two talest peaks will allow one to quickly determine the boundary separating black from white. This, however, is not always the case.

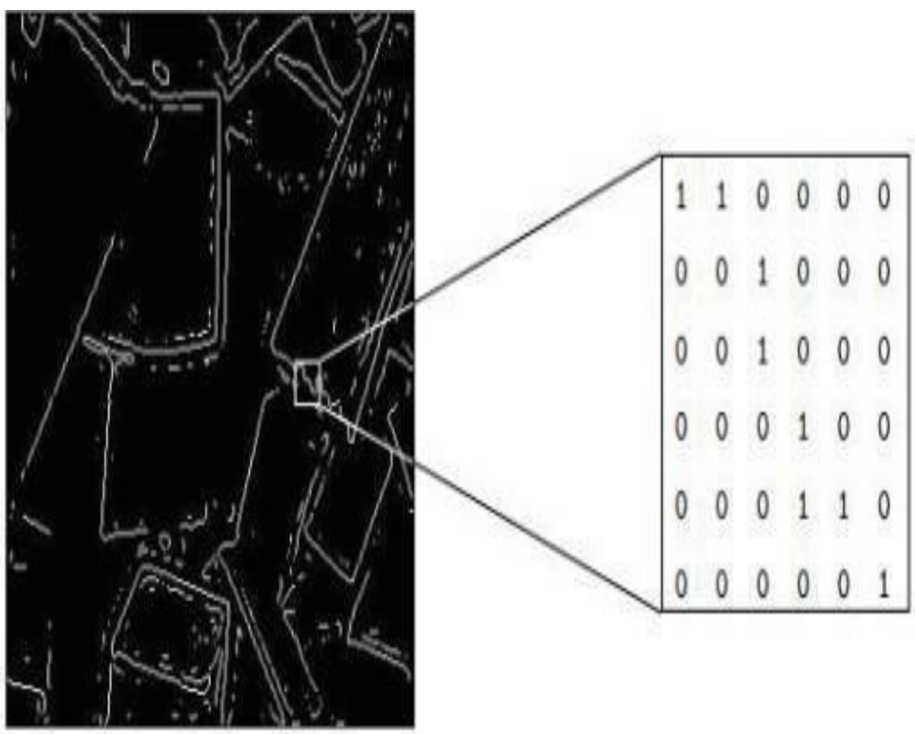


Fig 2 Pixels of a Binary image.

1.2.5.2 Grayscale Images:

Each pixel in the grayscale image has a shade from 0 (black) to 255. (white). One byte, or exactly eight bits, can be used to represent each pixel in this fashion. This is a typical range for managing image files. Greyscale's standard power is 2. Such images can be found in X-rays, printed art, and in fact, 256 different shades of grey are sufficientto identify most natural objects.

A greyscale image requires less data to keep each pixel since there is no colour information to convey, hence an additive colour model is not needed. The only information needed to indicate the intensity of each pixel in a greyscale image is a single number; the greater this value, the lighter the shade of gray.

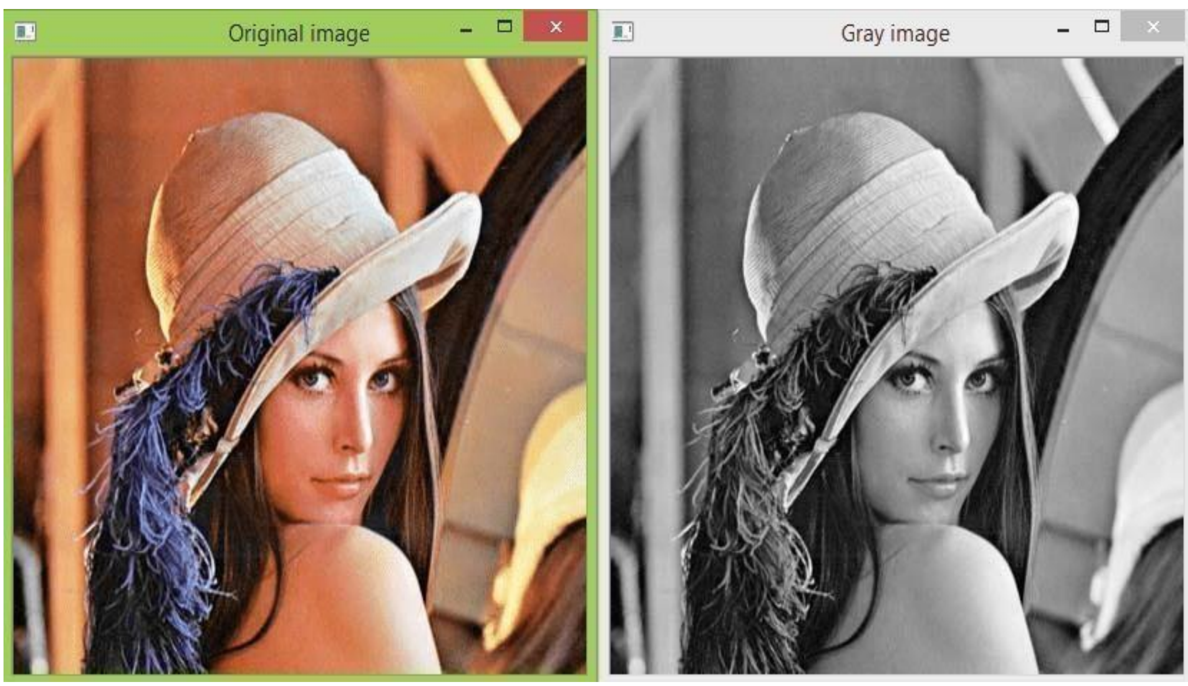


Fig 3 Two different images showing the difference between RGB and Grayscale image.

230	229	232	234	235	232	148
237	236	236	234	233	234	152
255	255	255	251	230	236	161
99	90	67	37	94	247	130
222	152	255	129	129	246	132
154	199	255	150	189	241	147
216	132	162	163	170	239	122

Fig 4 GrayScale image with different intensities of grey. Higher number represents contrasty look.

1.2.5.3 Truecolor or RGB:

Here, the number of red, green, and blue planes within each pixel determinesthe specific hue that it has. There are 16,777,216 distinct colors that might be created if the component ranges from 0 to 255. Images that require a total of 24 bits for each pixel are referred to as 24-bit color images. This imageis made up of three matrices, one for each of the colors red, green, and blue in a pixel. This implies that there are three values that correspond to each pixel.

An RGB picture is sometimes reffered to as a “3 channel image” because, as its most basic level is an additive colour in which each colour is represented by a combination of red, green, and blue values. These values are typically kepts as independent “channels”.

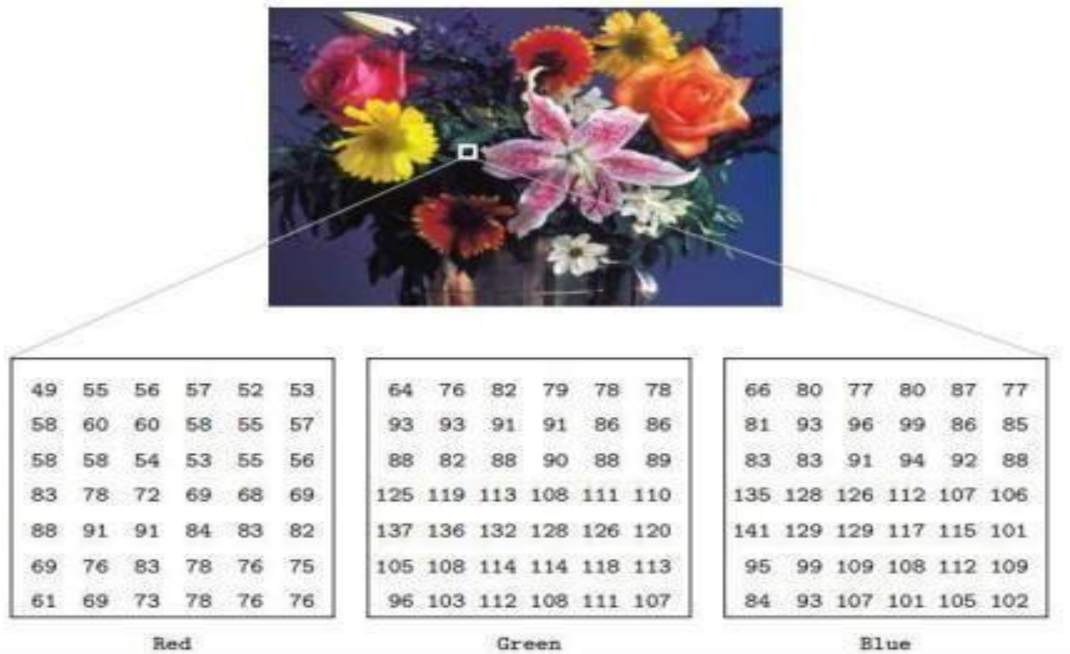


Fig 5 RGB image with different intensities of red, green and blue channels.

1.2.5.4 HSV Model Image:

Based on an RGB image, the HSV color model image Hue, Saturation, and Brightness are referred to as HSV.

- Hue is a "attribute of a visual sense wherein a region appears to be comparable to one of the perceived hues, such as red, yellow, green, or blue, or to a combination of them."
- Saturation: The amount of color in a region relative to its brightness.
- Brightness is the quality of a visuual perception that describes how muchor how little light an area appears to emit.

The HSV model primarily uses a cylindrical coordinate system. It is primarily founded on three elements.

- The degree indicates the color of that pixel because H (hue) represents the circumference.
- The distance from the cylinder axis is S (saturation).
- V (value, often known as brightness) is typically expressed as a numberbetween 0 and 1. where a pixel with a value of 0 is black. From all of these, the HSVmodel can be seen in the figure as a cone.

HSV has the benefit of generalising how the people perceive colour. Therefore, it is the most realistic representation of how colours actually appear on a computer screen. Additionally, the HSV colour space divides the colour and luma information. As the histogram equalization will only be necessary for intensity values, this enables us to carry out the actions.

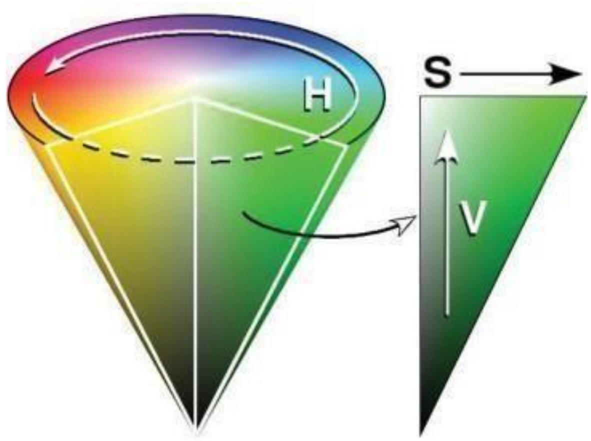


Fig 6 Image showing different components, Hue, Saturation, and Lightnesss

3. IMAGE ENHANCEMENT

1.3.1 Introduction

The primary goal of picture enhancement is to improve the input. Image for the increment's results to be appropriate for the intended use. Based on factors like contrast, edges, boundaries, etc. The image enhances the desired result. The amount of the original information will not be increased by enhancement.

Instead, it will broaden the dynamic range of the selected features, not the range of the data.

Quantifying the standard for image enhancement is the main challenge. Enhancement strategies necessitate participatory processes because they are about improvement to achieve the desired results.

There are two basic ways to process a picture, known as the spatial domain and frequency domain, depending on the processing domain.

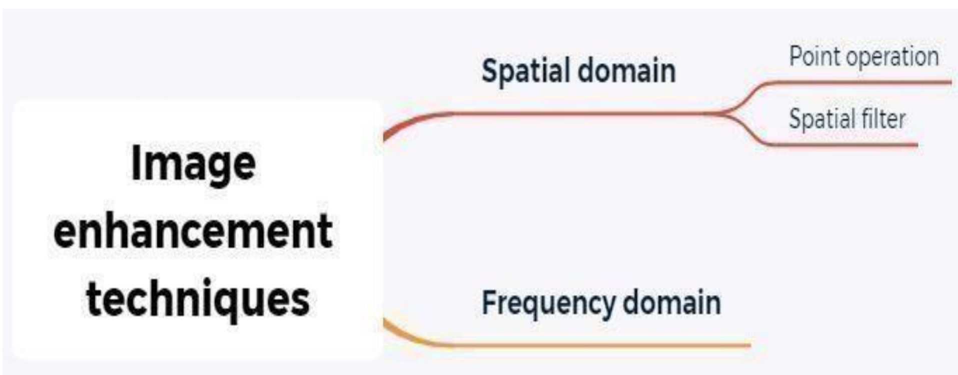
The primary image plane in which it directly altered the image's pixels is referred to as the spatial domain processing. The fundamental step in frequency domain processing is to alter the spatial frequency spectrum of the picture as defined by the Fourier transformation...

1.3.1.2 Spatial domain enhancement methods:

The group of pixels that make up the image are referred to as the spatial domain technique, and it works directly on these pixels. The following formula is used torepresent the spatial image processing function:

g(x, y) = T [f (x, y)].

In this case, the input image information are f(x, y), the output image information are g(x, y), and T is the working performed on the set of input photos, such as doing pixel- by-pixel sums or averaging a number of images for noise reduction. In order to prevent the snowball effect of the altered grey levels, the resultant is saved independentlyin thiscase rather than modifying the pixel values



Spatial Domain is of two types:

1. Point Operation.

2. Spatial Filter.

The spatial domain of the RGB image is represented as a 3D vector of 2D matrices.

The coordinates of each pixel in the 2D matrix, x, and y, are used to represent each pixel's intensity as I(x,y). This value performs a variety of operations.

1.3.1.3 Frequency Domain Method

The convolution theorem is the foundation of the frequency domain method. An image that has been processed is created by intricacy of an image with location f (x, y). Operation with invariannt h (x, y).

$$f (x, y) = hg (x, y) (x, y).$$

The given below frequency domain relation is obtained by the convolution theorem: Here, 2D convolution is used to perform DFT in the frequency domain.

G (u, v) equals F (u, v) H (u, v).

Where H, G and F are the corresponding Fourier transformations of h, g and f. H (u, v) (u, v) represents the process's transfer function.

1.3.2 Histogram Processing:

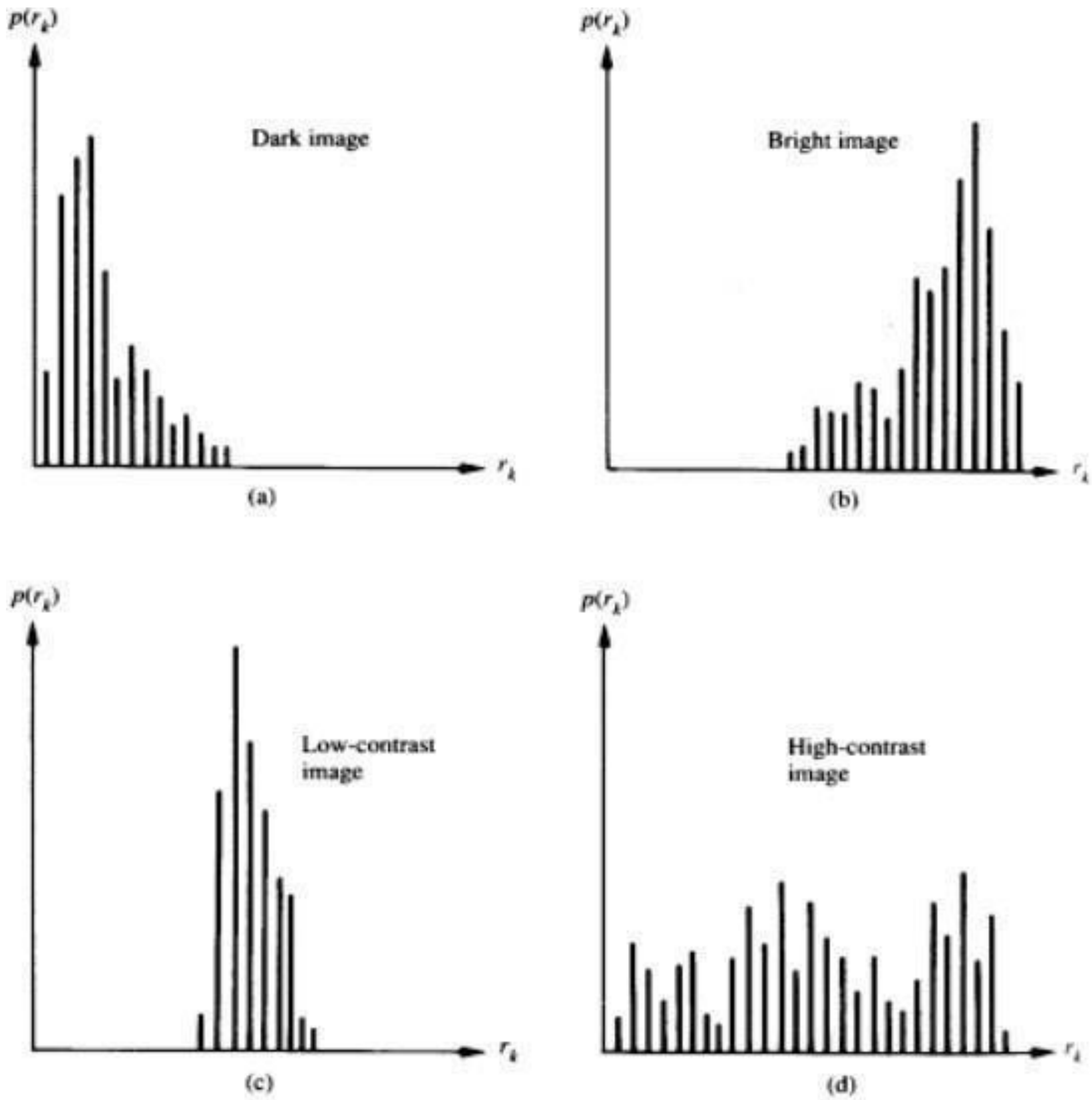
A digital picture's histogram, which is a discrete function with grey levelsbetween [0, L-1],

$$P(r_k) = n_k/n$$

The amount of gray-level pixels inside the original raw photo is shown below. There are n total pixels in the image, and k is the grey level, which is defined with k=0, 1...L-1.

P provides the expected probability of grey scale occurrence ().

Red, Green, and Blue channels of an image cannot each of have thier own histogram equalisation since doing so would drastically alter the image's colour balance



Graph 1 (a) Histogram of a dark noisy image, (b) Histogram of a bright image, (c) Histogram of a low Contrast image , (d) Histogram of the high contrast image after stretching the low contrast image.

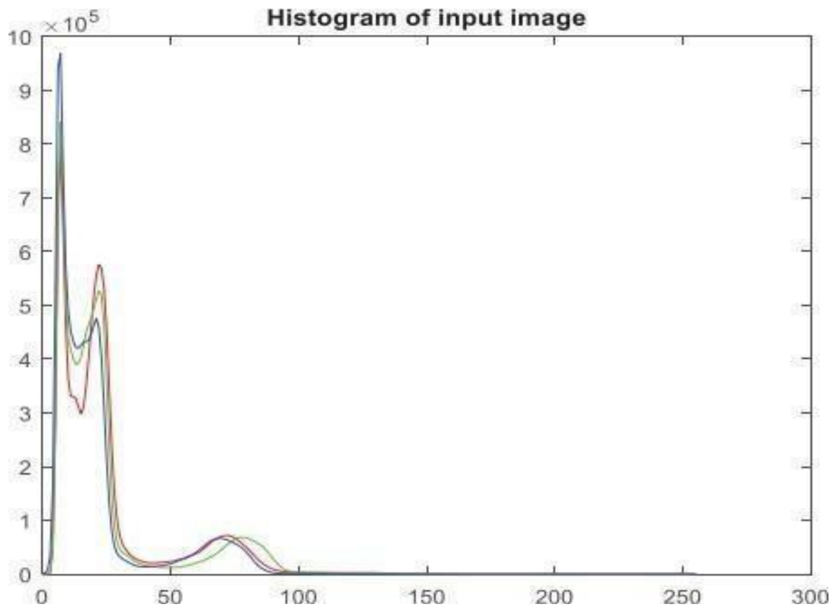
1.3.2.1 Histogram equalization:

- Histogram equalization's primary aim is to make the histogram that, after being related, is uniform by relating an input image to an output image.

- Here, the image's gray levels will be constituted by r, and the enhanced output will bes, with a transformation of s=T. (r).

- A transformation function equal to the cumulative distribution of the probability density of the image pixels, r, is used to change a picture into grey levels with uniform density, increasing the dynamic range of the pixel in the process.

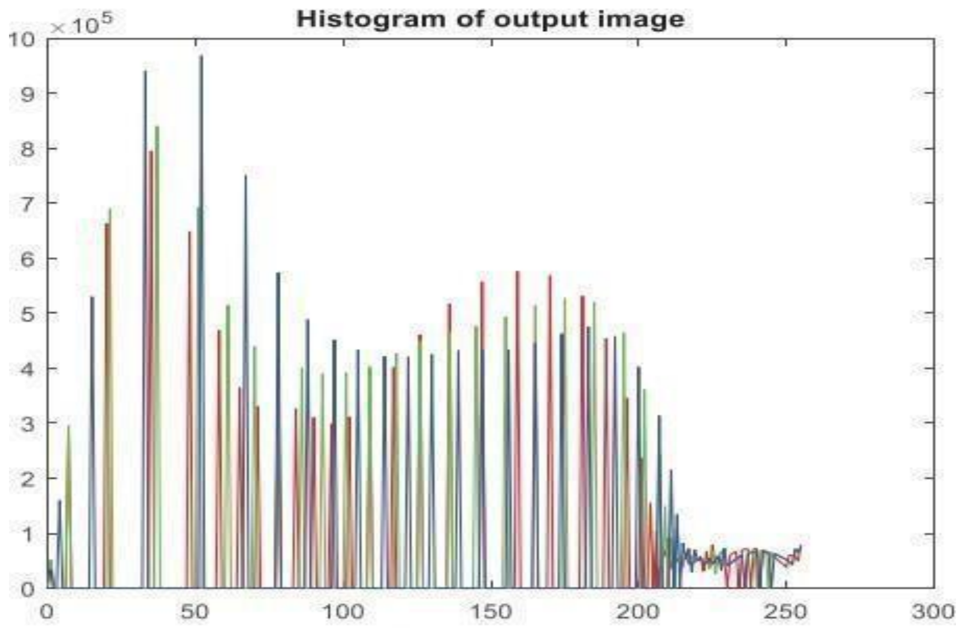
Fig 6 Sample Dark Image.



Graph 2 Histogram of the sample image.

Fig 7 Output of the sample image after applying the histogram equalization.

Graph 3



Graph 3 Showing the Histogram of output image

To improve the contrast of the image, histogram equalisation spreads the intensity values over the entire range. Because the histogram equalisation technique only adds extra pixels to the light portions of the image andsubtracts extra pixels from the dark sections of the image, the produced image has a large dynamic range and cannot be used for photographs with backgrounds that are illuminated unevenly. Histogram equalization aims to distribute an image's contrast uniformly across the whole dynamic range that is accessible.

However, it is not necessary that the contrast will always be increased. Sometimes after applying histogram equalization the image gets noisier and blurrier as a result of increment in global contrast.

That’s why we need to perform filteration and V transformation to get clearer image.

The process of histogram equalization involves changing the probability density function (pdf). To put it simply, the probabilty density function (pdf) of a certain image is changed by the histogram equalization method into a uniform function that extends from the loweest pixel value (in this example, 0) to the maximum pixil value (L1). In the event that the pdf is a continuouss function, this might be finished rather rapidly. However, and since we are dealing with the digital image, the pdf will be a non-continuous function. Assume we have an image x with a dynamic range of intensity from 0 (black) to L1 (white). This pdf on the histogram may be approximated using the probability based on the data as follows:

$$pdf(x) = p(r_k) = \frac{total\ pixels\ with\ intensity\ r_k}{total\ pixels\ I\ image\ x}$$

We can then derive the cumulative density function (cdf) from this pdf as follows:

$$cdf(x) = \sum_{k=0}^{L-1} p(r_k)$$

where the probability of an intensity pixel is given by p(rk). A pixel's yield after the histogram equalisation process is therfore equal to the image's Cdf or, more precisely, to its mathematical value.

1.4. ENHANCEMENT IN IMAGE PROCESSING

1.4.1.1 Introduction

Image enhancement enhances or improves the image's visual quality. The most straightforward and appealing aspect of digital image processing is image enhancement. The methods used for enhancement bring out specific features of interest in an image and accentuate their details. For a better-looking image, boost the contrast and brightness. Image enhancement is used to make digital images better suited for display orother picture analysis, such as noise reduction, sharpening, or image brightness. Frequency domain and spatial domain are the two basic divisions of the image enhancement process. In the frequency domain, techniques work with the image's frequency transform, whereas in the spatial domain, they can work directly with the pixels.

1.4.1.2 Contrast enhancement

The tonal augmentation of the image produces contrast inhancement. It improves the brightness differences uniformly across the image's dynamic range, in contrast to tonal enhancement, which only makes adjustments to the brightness differences in the shadow (dark), midtone (gray), or highlight (bright) regions as necessary to account for the brightness differences in the other regions.

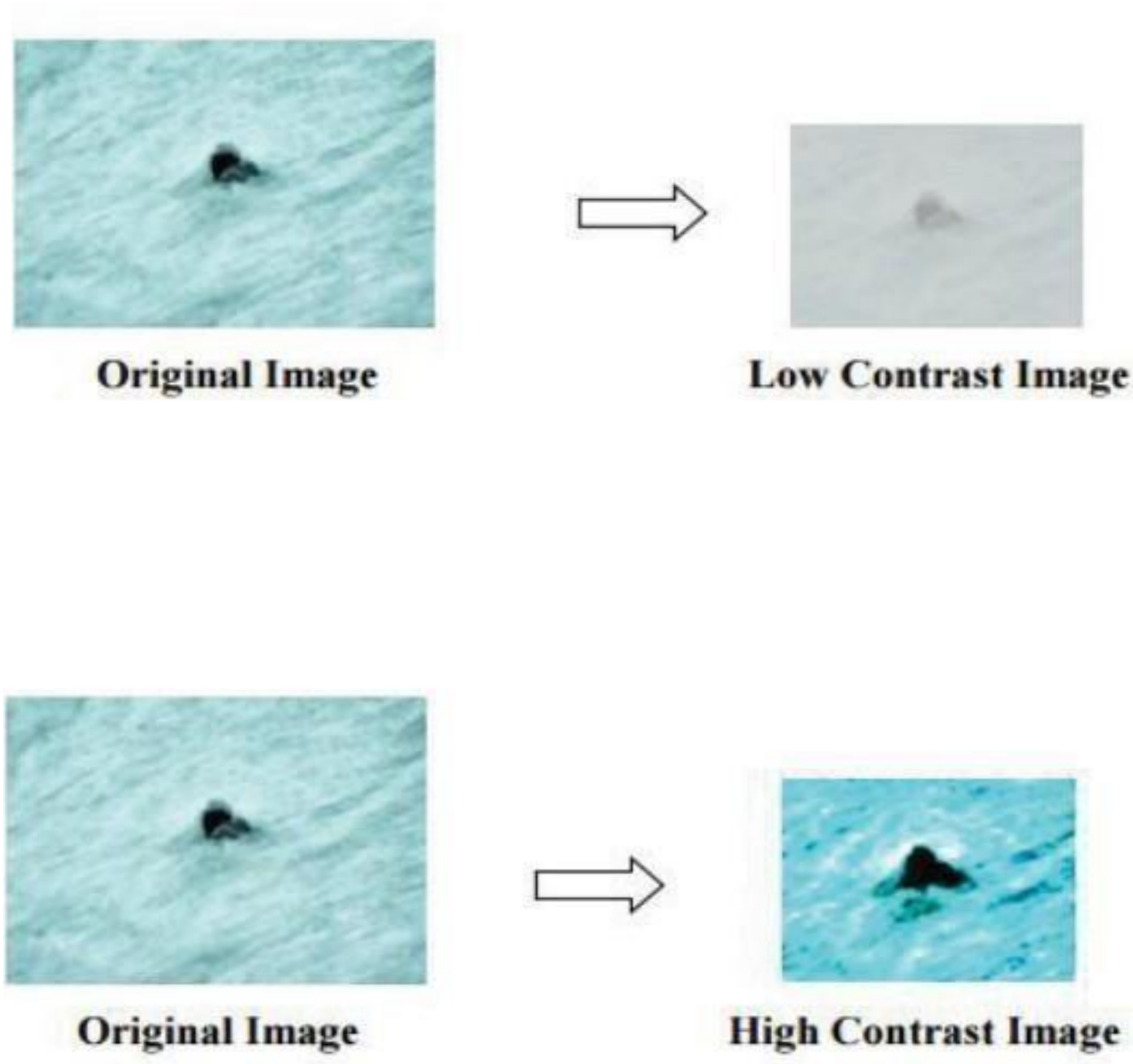


Fig 8 Two distinct images showing high contrast image and low contrast image of the same picture.

The function f, which is also in charge of changing the input picture's histogram, determines how the pixels in the final image are modified.

1.4.2 Some Proposed Algorithm:

1.4.2.1 Contrast Stretching

The dynamic range of the gray level in the picture is expanded using this technique. Poor lighting, a deficiency of dynamic range in the image sensors,and incorect lens's aperture selection during image acquisition can all lead tolow contrast photographs.

1.4.2.2 Gray Level Slicing

The main goal is to display a particular spectrum of gray levels. Display a high value for each grayscale within the interest range and a low value for each additional grayscale: make a binary image. Brighten the desired greyscale range while preserving the backdrop and grayscale tonalities.

1.4.2.3 Bit Plane Slicing

8 bits are used to represent each pixel. so there are eight 1-bit planes in the image. It is possible to determine the appropriateness of the number of bits used to quantize each pixel by dissecting a digital image into its bit planes and examining the relative relevance played by each bit of the image.

1.4.2.4 Histogram Equalization

One technique for enhancing contrast in a picture by using the histogram is known as histogram equalization [7]. Histogram equalization's primary purpose is to improve the histogram's distribution of intensities and boost the image's overall contrast. This makes it possible for regions with less local contrast to acquire more contrast. This technique works well for the image's foreground and background when they are both bright and dark.

To improve the contraast of the image, histogram equalization is used. This spreads the range of intensity values. When the background of an image has uneven illumination, this approach cannot be applied. The output image has a high dynamic range because this process only integrates extra pixels to the light regions of the image and abstracts extra pixels from the dark regions of the image.

Two techniques are used to perform histogram equalization.

1. Histogram Equalization on RGB color image:

The histogram equalization algorithm is used to independently equalize the independent R, G, and B planes in a color image. The RGB space's individual channels were each processed and equalized separately. Following that, all of the RGB components are combined to create a better image than the original.

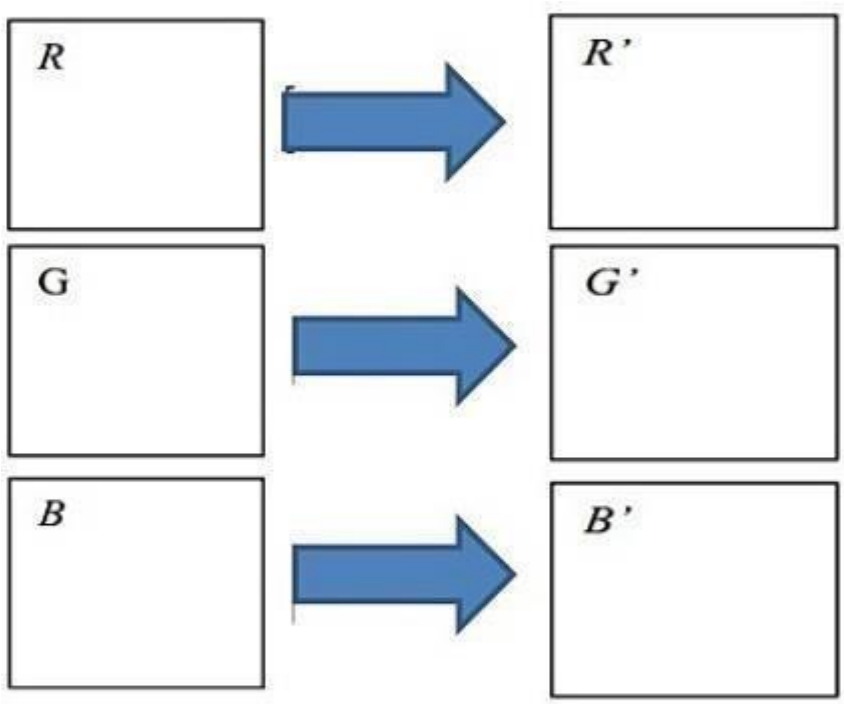


Fig 9 Diagram showing how the intensities change of respective channel.

Probability density function (pdf) that is being operated in the histogram equalization approach, to put it simply, transforms the pdf of a given imagee into a uniforrm pdf that spreads out the lower pixel (0) to maximum pixel value (m-1) In this manner, the dynamic range of the image, which lies between 0 and 1, is distributed uniformly. When the pdf is operating continuously, this can be done. However, there will be a discrete function for the digital image pdf. Let's say we have an image called x with a dynamic range of 0 (black) to m-1.

2.Histogram Equalization using V Component from HSV Color Space:

This approach requires that the image be transformed to hue, saturation, and

HSV (luminance) color space. Saturation reveals the relative color purity (amount of white light in the color), while hue appears to be directly tied to the ascendantwavelength of the color stimulus. The chromaticity coordinates are the terms used to refer to hue and saturation when combined (polar system). This technique uses histogram equalization, which is applied to the HSV color space's V component. The newly acquired values are combined with H and S in the v plane following equalization.The equalized image is then compared to the input image.

$$HSV \rightarrow H, S, V$$

$$V \rightarrow V\ (\text{equalize})$$

$$HSV\ (\text{equalize}) \rightarrow H, S, V\ (\text{equalize})$$

Chapter 2 Literature Review

2.Literature Review

IMAGE CONTRAST ENHANCEMENT USING HISTOGRAM EQUALIZATION [1]

Without adding visual artifacts that lower an image's visual quality and give it an unnatural appearance, the contrast of the image can be increased. In comparison to previous contrast enhancement algorithms, the experimental results demonstrate the algorithm's efficacy. The obtained photographs have an appealing aesthetic, are free of artifacts, and appear natural. The absence of flickering in this paper is a positive aspect. This is mostly because the input (conditional) histogram, which does not greatly alter within the same scene, is used by the algorithm as the main source of data. A wide range of photos can be used using this technique. Additionally, it provides a degree of controllability and adaptability that enables various degrees of contrast augmentation to no contrast enhancement.

IMAGE ENHANCEMENT USING BACKGROUND BRIGHTNESS PRESEREVING HISTOGRAM EQUALIZATION [2]

Proposed the Histogram equalization approach, which is frequently used to improve the image contrast but has a tendency to excessively boost the brightness of the image background. By splitting the image into two segments based on the input mean, the brightness-preserving bi-histogram equalization (BBHE) was proposed to maintainthe brightness of the image. The resulting image is created by separately equalizing and combining the sub-images.

NONLINEAR TRANSFER FUNCTION-BASED LOCAL APPROACH FOR COLOR IMAGE ENHANCEMENT [3]

Developed a technique for improving color photographs based on pixel neighborhood and nonlinear transfer function while maintaining details.

To prevent the deterioration of the color balance between the HSV componeents, this method only applies image inhancement to the V (luminancee value) component of the HSV color image, leaving the H and S components alone. Two actions are taken toenhance the V channel. The brightness enhancement is done using a nonlinear transfer function for each pixel inside each block after the V componentss image is first separated into smaller, overlapping block. The second phase involves further enhancing each pixel so that the image contrast can be adjusted based on the values of the centerand surrounding pixels.

CONTRAST ENHANCEMENT OF DARK IMAGES USING STOCHASTIC RESONANCE [4]

Suggest a method based on stochastic resonance that is used to improve very low contrast photographs. An equation for the ideal threshold has been developed using this method. The low contrast image has been progressively upgraded with the increasing standard deviation Gaussian noise until the quality is at its highest.

ON THE IMAGE ENHANCEMENT HISTOGRAM PROCESSING [5]

The effective way for improving the image's contrast is histogram equalization. The natural occurrence of an image is not preserved because it is a source of high-enhancement. Multi-HE approach is employed to keep both brightness and natural occurrence of the digital image in order to overcome this limitation. The suggested method divides the histogram of an input digital image into a number of sub-histograms based on the mean and median threshold values. The number of segments, vital range of each slab, and intensity level are factors that areused to determine the narrow segments. It is scaled to the entire dynamic range after detecting the small portions, leaving the wider segments alone.

Every slab receives its own application of the histogram equalization. The normalization is ultimately produced for an equalized histogram to avoid intensity saturation and a jarring bin distribution. The contrast of the image is improved with better brightness preservation as the number of segments .

Chapter 3 System Development

3.1 Analysis

Here we are using a collection of images and drawing their respective Histogram and Adaptive Histogram Graph. Respective graphs are shown below.

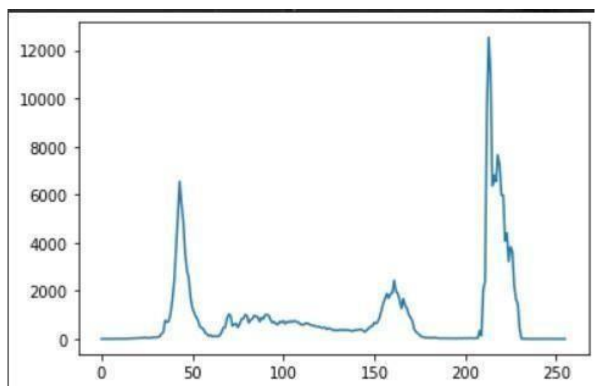
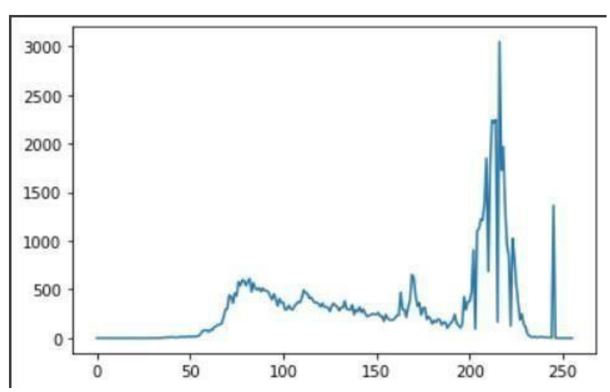
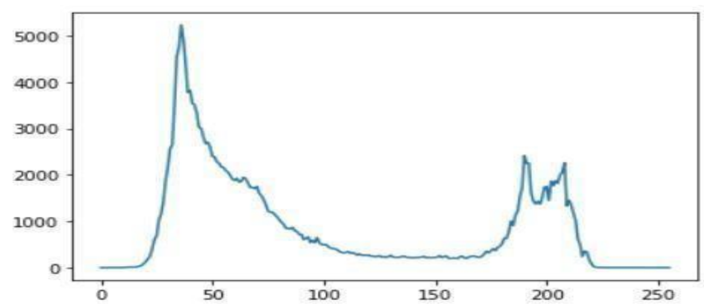
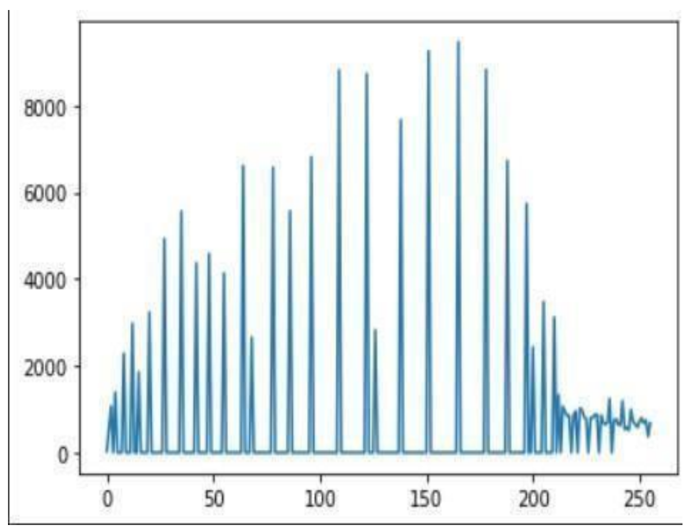


Fig 10 Sample Image







Graph 4 Adaptive Histogram of the input image

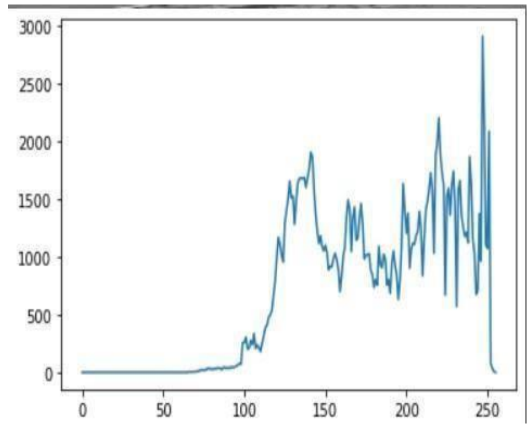
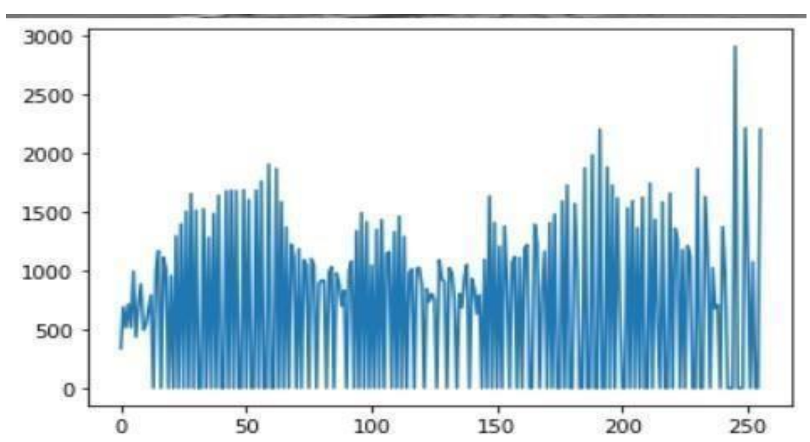


Fig 12 Sample image 3



Graph 5 Adaptive Histogram of the input image

3.1 Algorithm Used

3.1.1 Histogram Equalization

Histogram equalisation is a technique for adjusting contrast in image processingthat makes use of the histogram of the image.

When the image's useable data is represented by close contrast values, this strategy typically raises the overall contrast of numerous photos. The intensities on the histogram can be more evenly spread by making this adjustment. This makes it possible for regions with less local contraast to acquire more contrast. The most frequent intensitty values are efficiently dispersed via histogram equalisation to achieve this. The technique works well in pictures where the foreground and background are both dark or both bright.

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j)$$

3.1.2 CLAHE Histogram Equalization

CLAHE is an adaptation of Adaptive Histogram Equalization (AHE) that addresses the issue of contrast over-amplification.

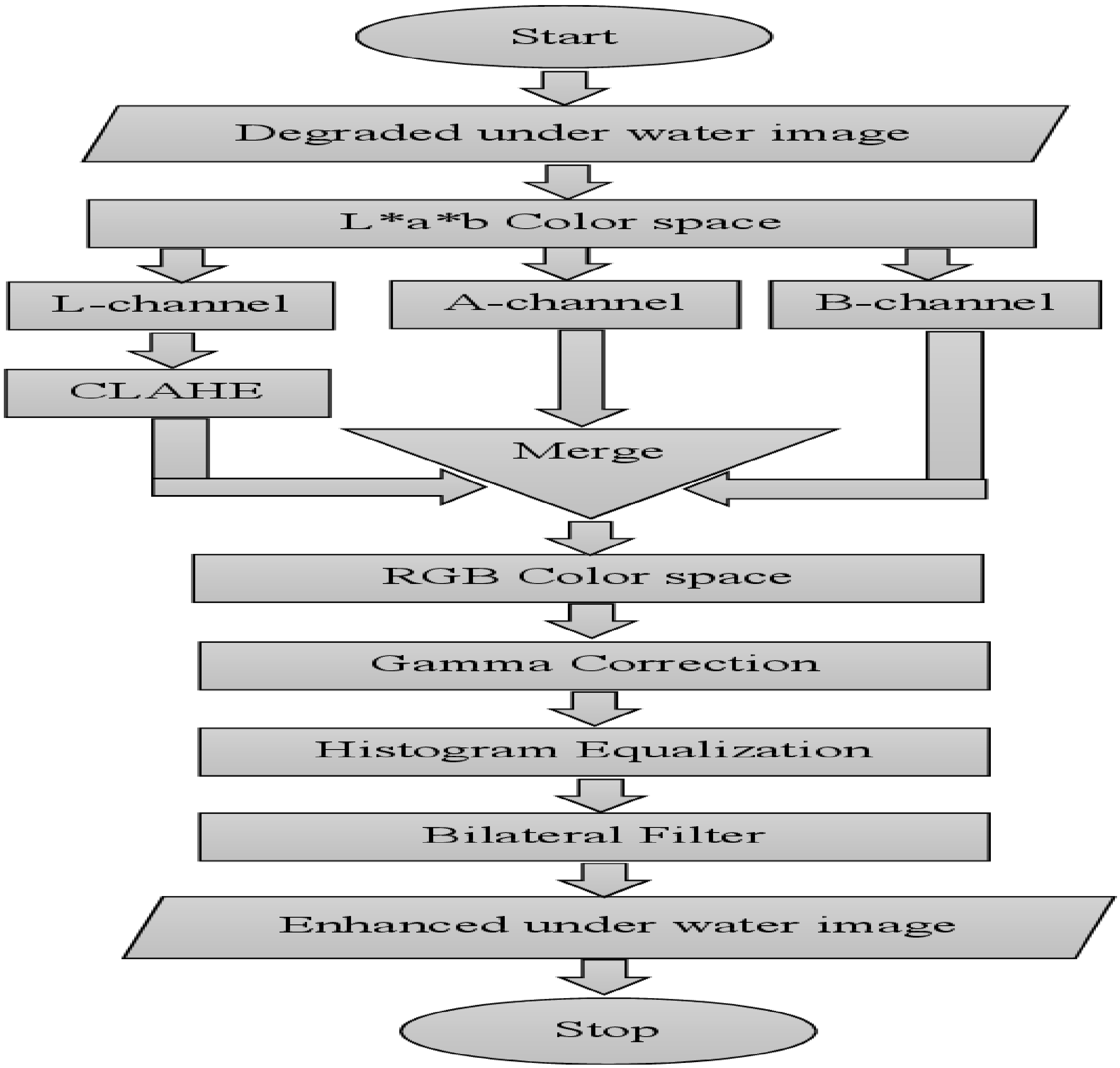
Instead of processing the entire image, CLAHE works with discrete sections of it called tiles. The falls borders are then eliminated by combining the adjacenttiles using bilinear interpolation. You can use this algorithm to make photographs' contrast better.

We may also use CLAHE on colour photos; typically, this is done on theluminance channel, and the outcomes are considerably better for an HSV image after merely adjusting the luminance channel than they are for a BGR image after adjusting all the channels of the image.

3.1.3 OpenCV

A substantial open-source library for computer vision, machine learning and image processing is called OpenCV. Today, it contributes siginificantly to real-time operation, which is essential in contemporary systems. It may be used to search for people, objects, and even human handwriting in images and videos.

When combined with other libraries, like NumPy, Python is capable of handling the OpenCV array structure for analysis. To recognize visual patterns and their many aspects, we employ vectore space and perform mathematical operations on these features.



Flow chart showing step by step procedure to perform CLAHE HistogramEqualization and Gamma correction

Chapter 4 Performance Analysis

Output at several stages are shown below

Image 1

Original Equalized

Fig 13 Input and Output results after applying Histogram Equalization.

Image 2

Fig 14 Input and Output results after applying Histogram Equalization.

Image 3

Original Equalized

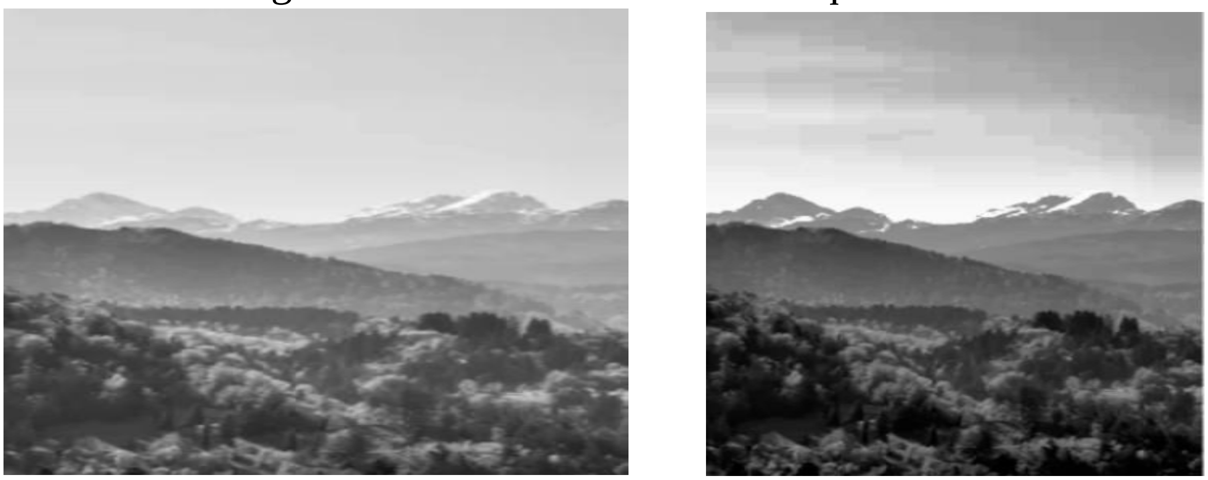


Fig 15 Input and Output results after applying Histogram Equalization.

Image 4

Original Equalized

Fig 16 Input and Output results after applying Histogram Equalization.

Image 5

Fig 17 Input and Output results after applying Histogram Equalization.

Image 6

Original Equalized

Fig 18 Input and Output results after applying Histogram Equalization.

Image 7

Original Equalized

Fig 19 Input and Output results after applying Histogram Equalization.

Chapter 5 Conclusion

5.1 Conclusion

This project proposes and applies methods for the enhancement of full color photos that strike a compromise between the demands of appearance enhancement and maintaining an image's original appearance. Results have demonstrated our algorithm's efficacy in enhancing the contrast and vibrancy ofthe source photos. With our own proposed histogram and three ways of histogram equalization on color images, we have demonstrated in this paper that we can get superior images through histogram specification.

The approaches used in this thesis are used to the enhancement of both RGB and greyscale images, balancing the requirements of the developed enhancement and maintaining the integrity of the original image. The outcomes demonstrate how well the algorithm worked to enhance the original image's color and contrast.

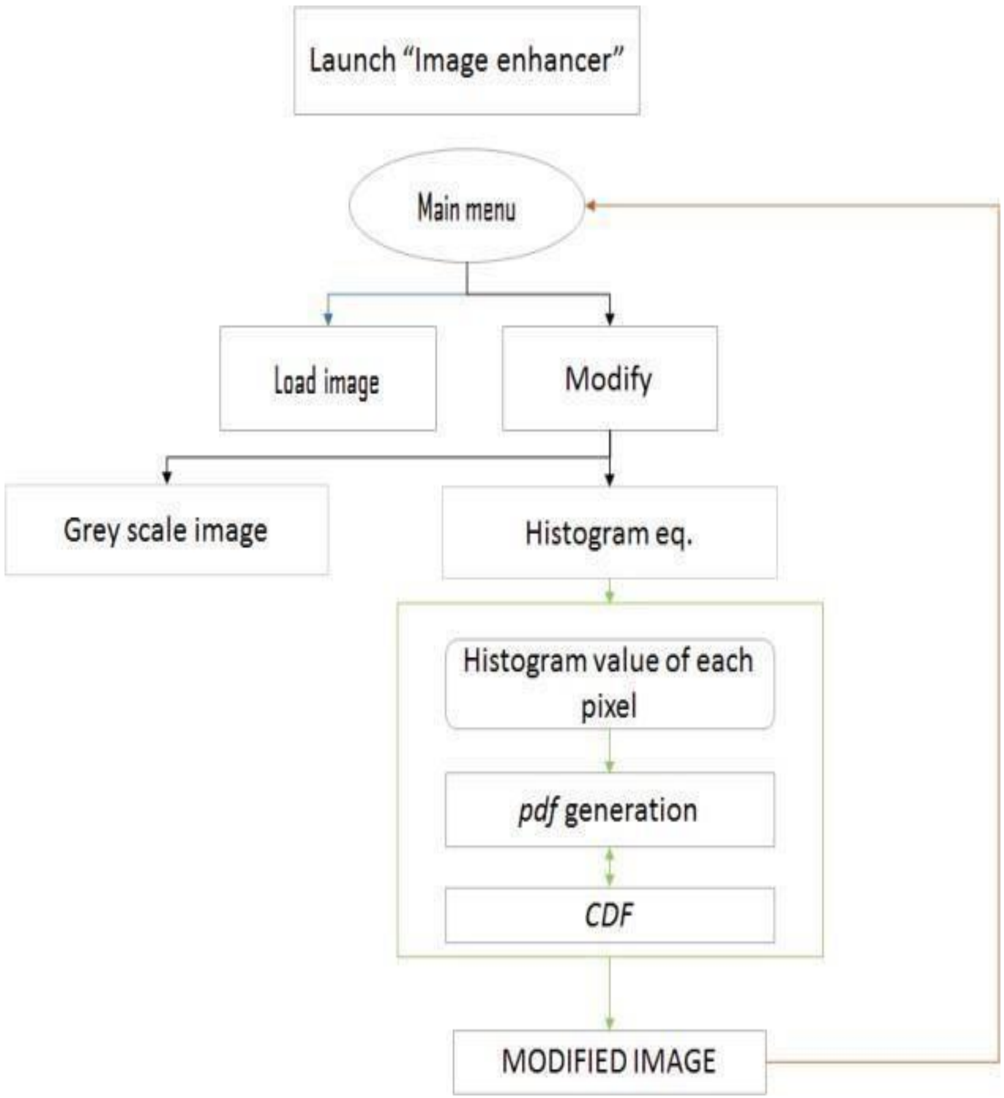
Finally, all the results are shown in the Chapter 3 and Chapter 4 where wehave compared the different techniques on different images and how efficient they are based on the given image.

5.2 Future Scope

Although all these techniques works perfectly fine and giving us favorable results.

We can use android studio to make it work on the every day smartphone as we believe that it will increase the user experience and will come much handy especially given in the smartphones.

A general flow chart of how our image enhancer will work is given below.



5.3 Application

The main idea behind this project is to increase the contrast of a very low contrast image while preserving all the necessary details and also reducing the noise and graininess. There are three types of histogram techniques used in thisproject but there are still a few more left like Gamma correction which can be very helpful if the input image is medical image modalities.

5.3.1 Magnetic Resonance Imaging

Nuclear magnetic resonance spectroscopy shares the same fundamentals as magnetic resonance imaging (MRI), a type of medical imaging. The most effective and noninvasive method for disease clinical diagnosis is MRI. The MRI scanner takes photographs of the body's tissues, organs, and other structures using magnetic and radio waves. An MRI scan produces images that are superior at portraying fine details. As a result, an MRI scanner can be used to take photos of all the body's tissue. The tissue with the least hydrogen atoms, such as bones, turns dark, whereas the tissue with the most hydrogen atoms, fatty tissue, appears much brighter.

5.3.2 Computed Tomography

The method known as computed tomography (CT) uses X-rays along withcomputer algorithms to create images of the body's tissues. In the field of medical imaging, the CT scan is one of the crucial diagnostic tools used to visualize the inside anatomy of the human body. Compared to other medical imaging techniques, it offers good contrast between various soft tissues of the body, which especially makes it useful for imaging the muscles, brain, and cancers. To improve the contrast of CT images that are used for diagnostic purposes, some technological advancements have been made to CT machines.

5.3.3 Adaptive Histogram Equalization

A technique called adaptive histogram equalization (AHE) uses localized histogram equalization and computes a new intensity value based on the local histogram specified in the local window for each individual pixel. Even though there are several quick approaches for updating the local histograms, adaptive features can still produce better results because computation is so difficult. By changing the values in the intensity image, the contrast of the image is improved using this technique. By delivering the desired information in a single image, AHE aims to get around the drawbacks of global histogram equalization. As a result, this method is more widely used and successful for enhancing the contrastof grayscale and colour images.

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